Manual for pulse oximetry with PC

The **RS232 test kit** has a SPO4025c OEM module with some extra circuit for working on a **RS232** interface. In this case the power supply of the pulse oximeter and of the sensor is taken from the handshake lines of the serial interface.

Please consider that on modern subnotebooks the RS232 interfaces are built such as to send just a minimum signal level. In this case it may be possible that not enough voltage is built up for the pulse oximeter. After connecting the test kits through **a null modem cable** the LED must blink with pulse rythm, if you put the sensor onto the finger. In problematic cases one can try it with a USB-to-RS232 adapter.

We will also offer on the comercial market test kits with built in USB interfaces instead of RS232 interfaces. Then you don't need a separate USB-to-serial adapter and the null modem cable anymore.

Before testing please download the program **CADT_Monitoring.exe**.
In order to start this application you also need a USB driver file, FTD2XX.DLL. Save both files in a folder on your PC.

The application program opens the serial interface, so that the pulse oximeter gets voltage and starts. For that you choose in the menu of application program: **Option -> Connection,** the serial interface, where you connected the serial test kit. In case of a com interface it is normally COM1 oder COM2, but if it has a USB-to-serial adapter it is e.g. COM3 or COM4. A USB-to-serial adapter must be installed with the proper driver software, before starting our application program!

The application program decodes the data stream from the oximeter module and shows the data in numerical way and as **Plethysmogram**. Red parts in the measurement curve show that the pulse oximeter adjusted the LED current or the preamplifier gain factor in one or more places. The plethysmogram curve must not show jumps, but continue as a smooth line. The black marks below the graph view the progress of the internal activities of the pulse oximeter module. E.g. the regular 0.1 second long marks indicate, when the pulse LED in the test kit was turned on.

The tables show the set value and the measured value of the **LED currents** in the sensor. The measured LED current must match with the set value. A discrepancy of more than 10 % means a problem in the sensor. Using a common sensor with two LEDs means the third column of the table is irrelevant.

In the third row we have the resulting voltage of the **photo diode**. For a good sensor it is about 1,5 to 2 V, in case of a low light sensor it is about 0,5 V. The fourth row shows under the inscription "ADC Sig" the measured variation of the signal voltage. This must not exceed more than 5 or 10 % of the signal. Otherwise reliable pulse oximetry cannot be guaranteed. Reason for that can be e.g. a defect sensor (e.g. defect cable) or an interference from an active cellular phone that is close to this place.

The value with the inscription **Gain** indicates the effective transimpedance resistance of the photo current preamplifier.

Below that there is a table row, which shows **RMS values** of single samples (50 Hz) of the measured photo signals. When you leave the sensor at rest for about 1 to 2 minutes, then these values indicate a measure for the noise of the pulse oximeter. It should not exceed 0.02 %. Sensitivity for low perfusion normally is a factor 2 to 3 lower, since a heart beat always appears in many subsequent samples, i.e. we are reducing noise by taking an average of several samples.

Afterwards the table shows the pulse oximetry ratings with a light blue inscription: **perfusion, pulse, pulse rise time, pulse jitter, saturation**. In addition to the perfusion value we show the probability for the current oximetric model in a range from 0 to 100. The measurement is considered "bad" , if this probability was less the 30%. In this case the previous results will be shown for a maximum duration of 5 seconds and afterwords they will disappear. Besides that, the results don't have any further dependence on the past. If the perfusion level was determined to be less than 0.1 %, the other pulse oximetric ratings will not be shown on the display.

The following table shows us 4 characteristic ratings:

- **Coding resistence of the sensor in** kOhm. These are typically values between 1 and 25 kOhm. Measurement accuracy reaches about 0.3 %.
- **Ambient light:** The pulse oximeter has a large ambient light reserve, it is about 12 times more than the typical LED photo signals and amounts to about 70 times the ambient light level, that is typically observed with the fairly open one way sensors.
- **Reference voltage of LED** current generator, may be between 0,45 and 0,47 V.
- **Chip temperature of the processor** in the pulse oximeter module. An exact temperature measurement requires the calibration of the temperature sensor.

If the pulse oximeter doesn't start, it can be a problem with the null modem cable. In this cable all the contacts must be connected, also the modem control lines. Due to the high data rate of 57,6 KBaud it is also important to activate the hardware **FiFo buffers** of the serial interfaces. Otherwise a successful data transfer is not possible under MS Win32.

By the way, while running our application program a **pulse oximetry record file** is written into the file fTxtLog.txt. You can save these files of format "text with tabs" and use them with MS Excel. These files can be very large. They will be overwritten once you start the application program.

Since May 2005 you can download the new **Version 1.02**. It contains these enhancements:
- Saving actual settings in a ini-file
- Selecting serial or USB interface in a selection dialog panel
- Selecting one of three plethysmogram curves (IR, Red, Red2)
- Selecting one of three data protocols
- Saving screen graphics as file or into clipboard
- Viewing HbCO measurements (Sensor with 3 LEDs)
- More buffer for incoming data packets (avoid losing packets with limited Win32 realtime performance)
- Disconnecting and (Re-)connecting the data channel for test purposes and for using with Bluetooth wristbox
- Optional acoustic signal for pulsation
- Complete refresh of screen graphics
- Error status message on connection problems